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LIVING FORAMINIFERAL DIVERSITY IN MARGINAL WATER BODIES, EAST COAST OF INDIA

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ABSTRACT

Foraminiferal diversity was calculated from surficial sediment samples collected in the marginal water bodies: Bendi lagoon, Vamsadhara estuary, Gosthani estuary, Visakhapatnam Harbour Complex, Balacheruvu stream, Chipurupalle stream, Sanidanigedda and Kakinada channel, located along the East Coast of India. The diversity was measured by using species number (S), Shannon-wiener information function H(S) and species Equitability (E) as diversity indices. These three diversity indices are higher in the Visakhapatnam Harbour complex than the other marginal water bodies. The depth and organic matter are the influencing factors for the high diversity of the fauna in the Visakhapatnam Harbour complex.

INTRODUCTION

Diversity expresses the relationship between the number of species present and the number of individuals. It provides a means of characterising environments independent of the particular species present. Different diversity indices have been used in foraminiferal ecological studies (Simson, 1949; Gibson, 1966; Nichol and Norton, 1969; Schnitker, 1969; Murray, 1973; Buzas and Gibson, 1969; Sengupta, 1971; 1979; Sengupta and Kilbourne, 1974; Ariza, 1983; Buzas, 1985 and Williamson, 1985). "Because some diversity indices are weighted more heavily towards species equitability or evenness, no single measure of diversity or communality structure exists" (Boltovskoy and Wright, 1969). Several studies have been undertaken on the foraminiferal diversity of the marginal water bodies, East Coast of India (Narappa, 1980, Nageswara Rao, 1979; Kaladhar, 1981; Chandrasekhara Rao, 1982 and Yeruku Naidu, 1983). As each index measures different relationships within a sample, it is preferable to use and compare several indices todescribeand measure differences between samples (Buzas, 1979 and Williams, 1985). This study employs three measures of diversity to investigate aspects of the foraminiferal assemblages.

1. Species number (S), the number of species per sample is the easiest and quickest — measured index of diversity. It fails to account for the relative proportions of species within a sample.

2. The Shannon-Wiener information function H(S) measures the average diversity of a sample:

$$H(S) = -\sum_{i=1}^{S} p_i \log_e p_i$$

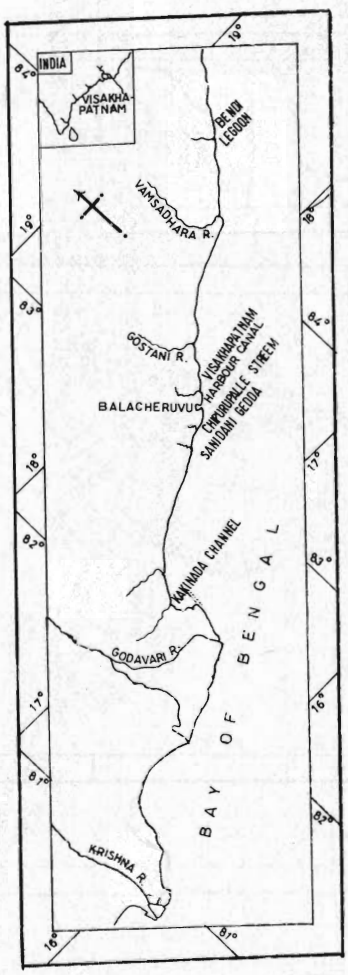

Fig. 1. Map showing general location of the areas under investigation.

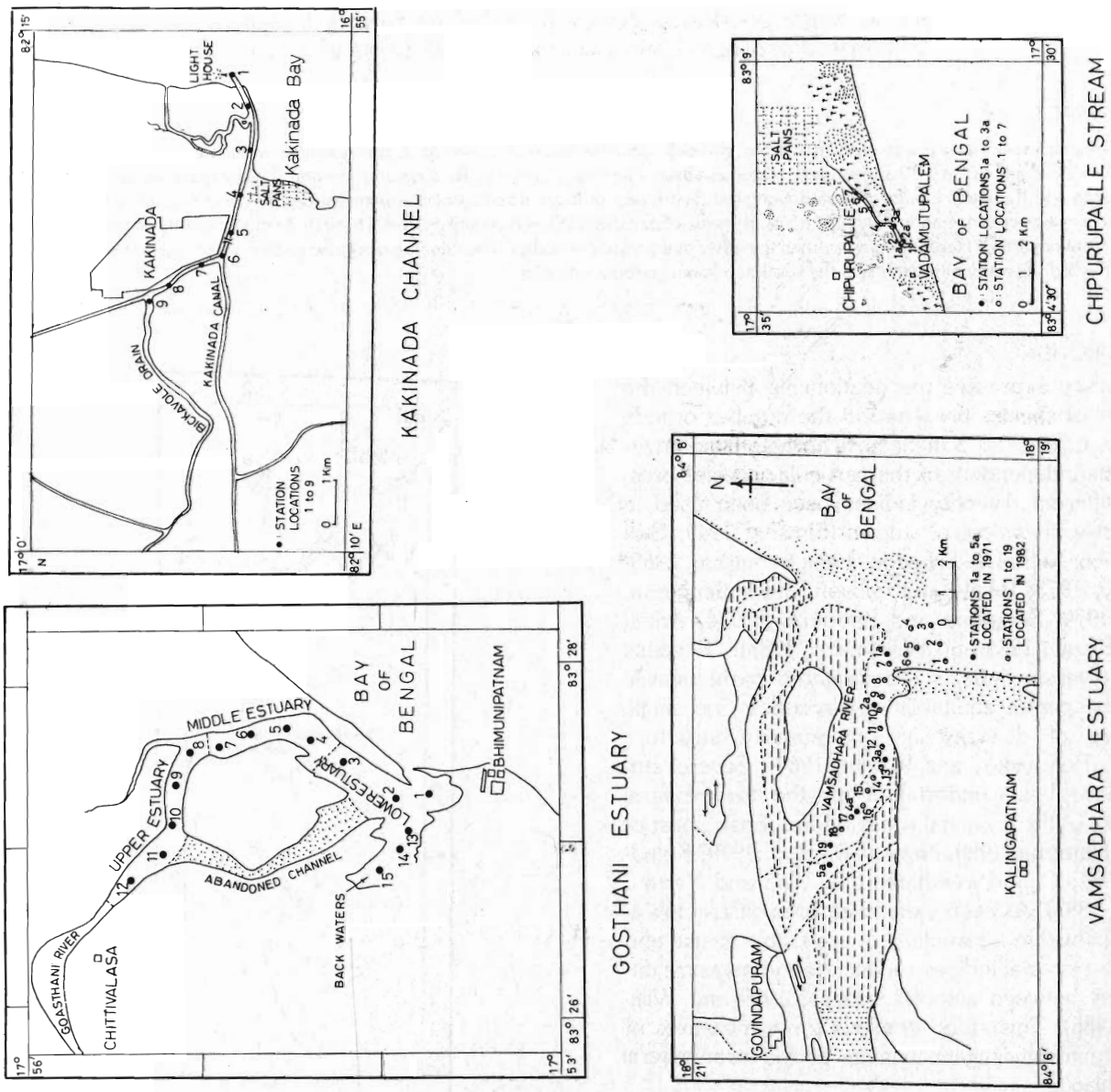

Fig. 1a. Station locations of the marginal water bodies.

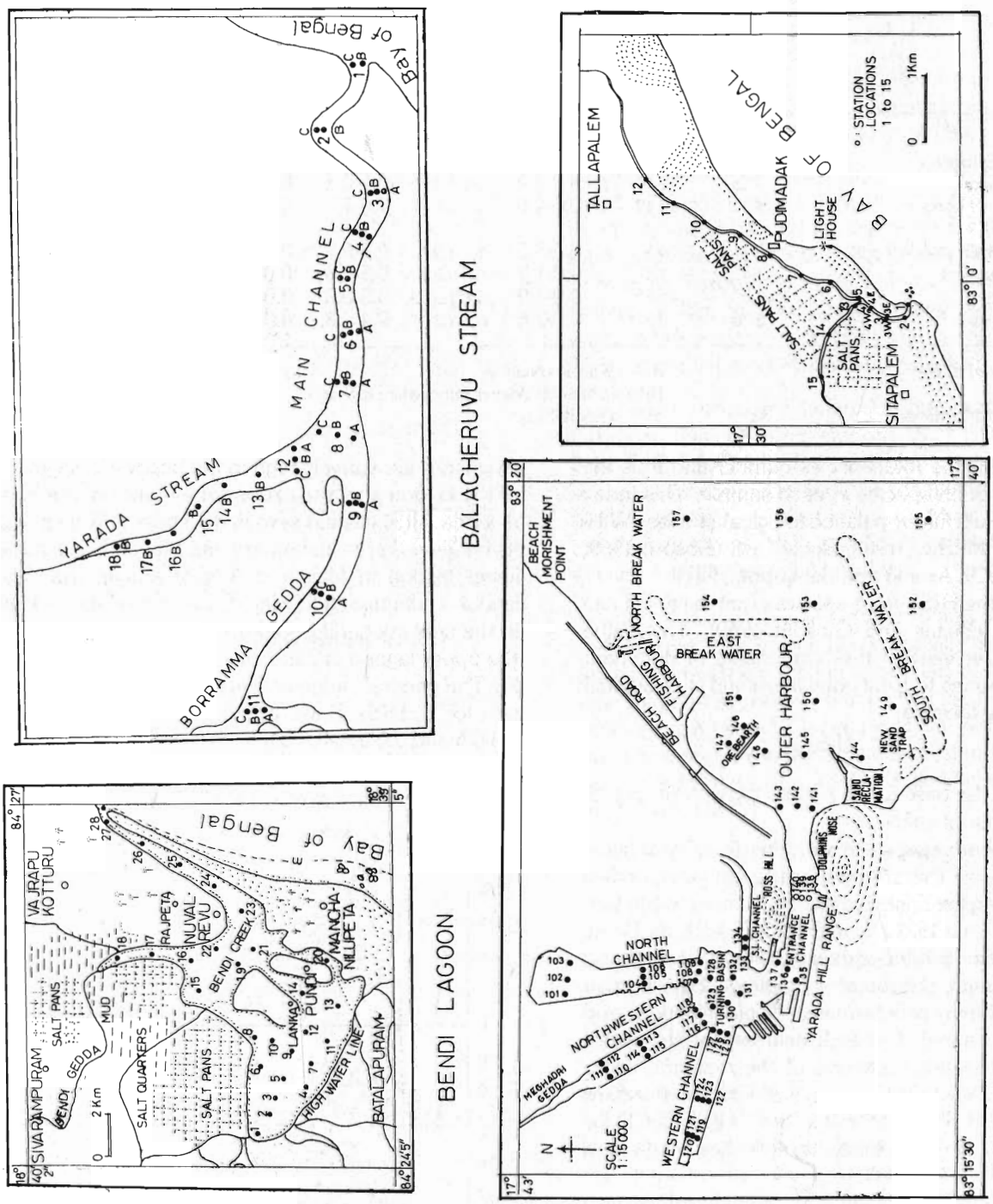

Fig. 1a. Station locations of the marginal water bodies.

Table 1: Mean, Standard Deviation and Observed range of S, H(S) and E for Living Foraminifera of various Water bodies

Name of the Water body	S			H(S)			E		
	O.R.	$\bar{X}$	S.D.	O.R.	X	S.D.	O.R.	X	S.D
Bendi lagoon	0-11	2-3	2-4	0.0-2.1	0.3-0.6	0.3-0.6	0.0-1.0	0.2-0.4	0.3-0.5
Vamsadhara Estuary	2-15	2-11	3-10	0.4-2.2	0.6-1.5	0.3-0.9	0.2-1.0	0.3-0.5	0.2-0.4
Gosthani Estuary	1-50	10-16	9-14	0.0-2.9	0.9-1.2	0.7-0.8	0.0-1.0	0.25-.3	0.2-0.3
Visakhapatnam Harbour Complex	0-80	15-17	15-19	0.0-4.0	1.6-1.8	1.0-1.1	0.0-1.0	0.5-0.7	0.3-0.31
Balacheruvu main stream	1-22	5-11	4-5	0.6-3.5	1.1-1.9	0.5-0.7	0.2-1.0	0.5-0.7	0.3-0.4
Chipurupalle stream	0-8	1-4	1-3	0.0-1.7	0.5-0.9	0.5-0.6	0.0-1.0	0.1-0.7	0.3-0.4
Sanidanigedda	2-21	3-8	1-3	0.0-1.9	0.6-1.3	0.3-0.8	0.0-1.0	0.4-0.8	0.2-0.4
Kakinada channel	1-22	2-10	2-5	0.0-2.6	0.5-1.2	0.4-0.8	0.0-0.9	0.2-0.8	0.1-0.3

O.R. = Observed Range
$\bar{X}$ = Mean
S.D. = Standard Deviation
S = Species Number
H(S) = Shannon-Wiener information function.
E = Equitability

Where S is the total species number and Pi is the proportion of ith species in each sample. This index has proved useful for palaeoecological studies (Williams, 1964; Murray, 1968; Buzas and Gibson, 1969; Douglas, 1979; Arnold and Sengupta, 1981).

3. From the H(S) value species equitability (E) can be defined (Buzas and Gibson, 1969). This value gives a better view of the relationship of dominant and rare species to total population and is calculated by using the formula

$$E = e^{H(S)}/S$$

where 'e' is the base of the natural logarithms and 'S' is the number of species.

The present paper deals with the diversity of living foraminifera in the selected marginal water bodies located along the East Coast of India, in between Lat. 18°26′ and Lat. 15°30′ Long. 80°30′, such as Bendi lagoon, Vamsadhara estuary, Gosthani estuary, Visakhapatnam Harbour complex, Balacheruvu stream, Chipurupalli stream, Sanidanigedda and Kakinada channel. General locations of the water bodies and station locations of the marginal water bodies are shown in Fig. 1, 1A and mean, standard deviation and observed range of S, H(S) and E for living foraminifera of various water bodies are given in Table 1.

RESULTS

BENDI LAGOON: The values of S, H(S) and E are ranges in 0-11, 0-2.1 and 0-0.99 respectively. The S value is always poor in the tidal inlet except in August. It is relatively high in the headward segment of the lagoon and also around the mouth of the bendigedda. H(S) value is zero in the entire tidal inlet and its headward area in January and May. It is 1.0 in the lower lagoon in May and August and in the upper lagoon in January and May. E value is relatively high in the tidal inlet and headward area in August and in the upper lagoon in January and May (shown in Fig. 2). The general range of mean, and standard deviation for S, H(S), E are 2.0 to 3.0, 2.0-4.0 and 0.3-6, 0.3-0.6 and 0.2-0.4, 0.3-0.5.

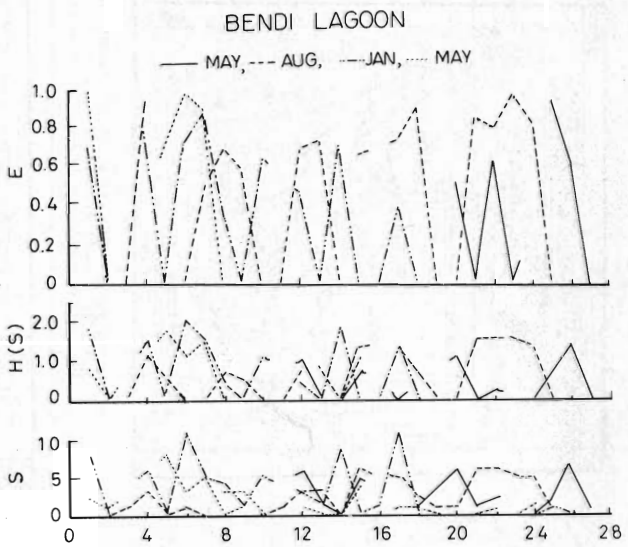

Fig. 2. Living foraminiferal diversity in relations to stations.

VAMSADHARA ESTUARY: In Vamsadhara estuary the diversity indices interms of S, H(S) are relatively high in January and low in September. The equitability high in January and low in September and lowest in January. Generally diversity is highest at the mouth of the eastuary. The general range of S, H(S), E are 2-15, 0.4-2.2 and 0.2-1.0, (shown in Fig. 3b). Mean and standard deviation for S, H(S), and E are varies from 2.0-11.0, 3.0-10.0 and 0.6-1.5, 0.3-0.9 and 0.3-0.5, 0.2-0.4.

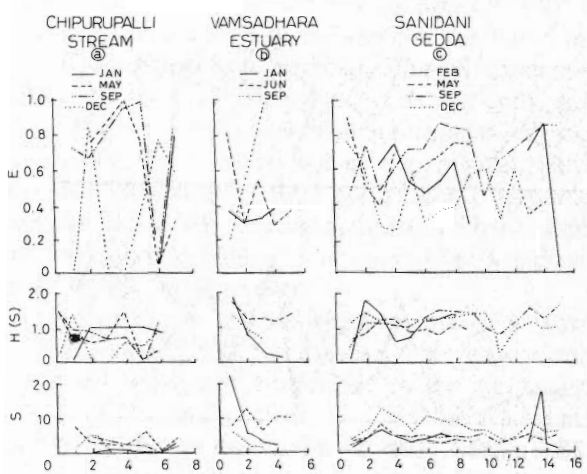

Fig. 3. Living foraminiferal diversity in relations to stations.

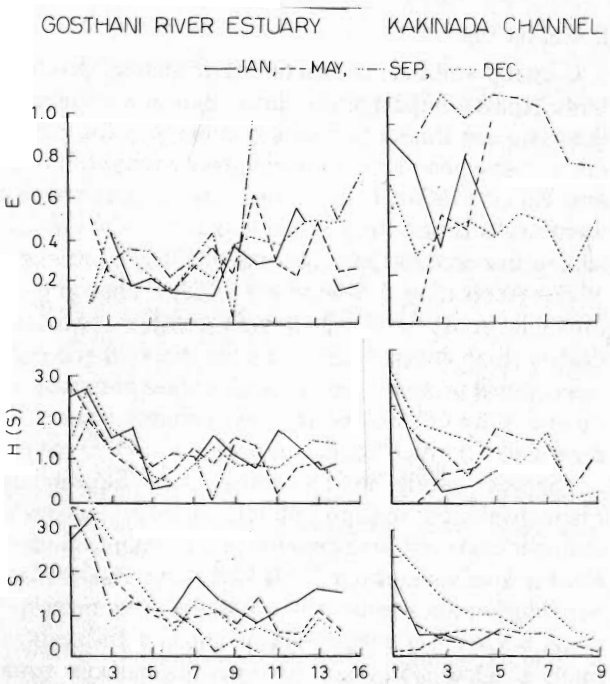

Fig. 4. Living foraminiferal diversity in relations to stations.

GOSTHANI ESTUARY: The diversity indices S, H(S), E ranges in between 1 and 50, 0 and 2.89, 0-1 respectively. S, H(S) values generally decreases between the lower segment to upper segment of the estuary where equitability increases. S and H(S) are relatively high in December and January where as E is high in September (shown in Fig. 4a). Mean and standard deviation for S, H(S) and E are varies from 10.0-16.0, 9.0-14.0 and 0.9-1.2, 0.7-0.8 and 0.25-0.30, 0.2-0.3.

VISAKHAPATNAM HARBOUR COMPLEX: S, H(S), E generally range between 0.80-0.4, 0-1 respectively. Generally outer harbour is having high diversity (S, H(S)) values than innerharbour whereas equitability is decreases from inner harbour to outer harbour in all seasons (shown in Fig. 5). The general range of mean and standard deviation for S, H(S) and E are 15.0-17.0, 15-19, and 1.6-1.8, 1.0-1.1, 0.5-0.7, .27-0.31.

BALACHERUVU STREAM: The fauna is more diversified in February than in other seasons. S = 1-22, H(S) = 0.6-3.5, E = 0.19-1.0. The part of the main channel supports a more diversified fauna than any other part of the waterbody (Shown in Fig. 6). Mean and standard deviation of S, H(S) and E are varies from 5-11, 4-5 and 1.1-1.9, and 0.5-0.7, 0.3-0.4.

CHIRUPALLE STREAM: S is in between 0 and 8, H(S) is 0 and 1.7 and E is 0 and 1.0. Generally S and H(S) values are relatively high in lower part of the stream where equitability is low. S and H(S) are high in September and May and E is relatively low (shown in Fig. 3a). The general range of mean and standard deviation for S, H(S) and E are 1-4, 1-3, and 0.5-0.9, 0.5-0.6 and 0.1-0.7, 0.3-0.4.

SANIDANIGEDDA: S, H(S), E values are in between 2 and 21, 0 and 1.9, 0 and 1.0 respectively. S and H(S) are relatively high in the lower segments (mouth) of the Sanidanigedda. S, H(S), E are high in December, September respectively especially in middle segments (shown in Fig. 3c). Mean and standard deviation of S, H(S) and E varies from 3-8, 1-3 and 0.6-1.3, 0.3-0.8 and 0.4-0.8, and 0.2-0.4.

KAKINADA CHANNEL: S. H(S), E values range in between 1-22, 0-2.57 and 0.91 respectively. S and H(S) are highest in December and low in May in lower part of the channel. The values decrease toward the upper part of the channel. Equitability values are poor in May and highest in August (shown in Fig. 4b). The general range of mean and standard deviation for S, H(S) and E are 2-10, 2-5 and 0.5-1.2, 0.4-0.8 and 0.2-0.8, 0.1-0.3.

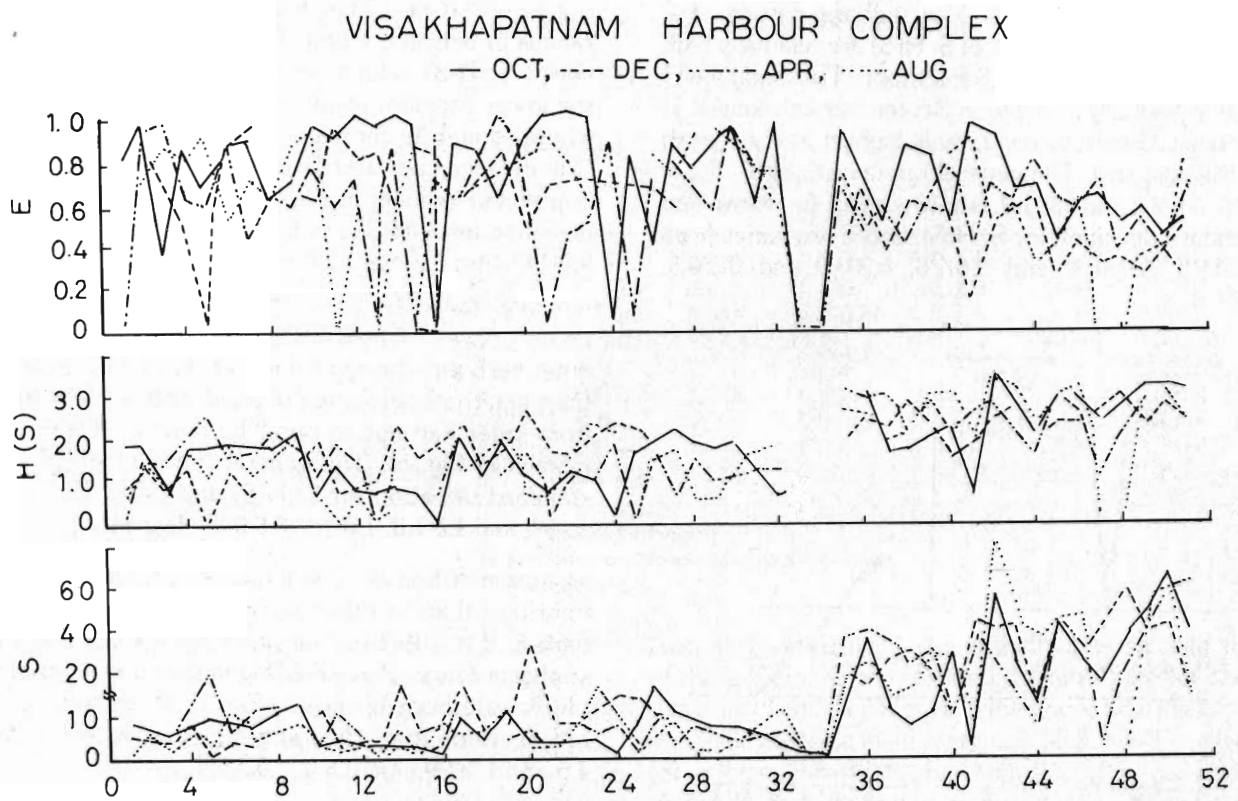

Fig. 5. Living foraminiferal diversity in relations to stations.

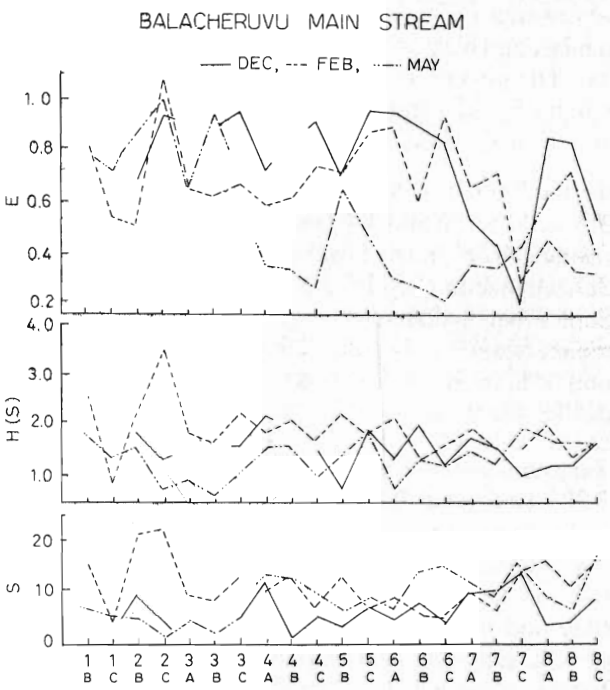

Fig. 6. Living foraminiferal diversity in relations to stations.

DISCUSSIONS

Climatic stability, competition, predation, productivity, spatial heterogenity, time environmental productivity are the factors which influences the difference in species diversity in different areas (Gibson and Buzas, 1973). If the foraminiferal communities were undisturbed they would evolve from immature to mature ecosystem (Margalef, 1963; Schnitker, 1971). According to Margalef (1963), a changing or unstable ecosystem will be less complex and less diverse than more stable environments where succession will proceed toward an increase in complexity and more efficient utilization of energy, thus high diversity. The high species number and H(S) values in Sanidanigedda in December and September respectively, especially in middle segments suggests that it is relatively more stable environment. Generally the species number (S) is highest in Visakhapatnam Harbour complex rather than the other marginal water bodies. It is a result of washing in of the tests of many shallow water species into the harbour area from the open sea. As the outerharbour is a basin deeper than the adjacent open sea floor (depth of this

basin is maintained by regular dredging), the washed in tests are retained here, adding to the diversity of the fauna. Some of these tests are transported further up into the inner harbour by tidal currents. H(S) value is also highest in this waterbody because of the occurrence of more species. The values of H(S) obtained indicate the trend of increase in diversity with increasing depth (Ariza, 1983; Ellision, 1979). The highest equitability value indicates that the species are equally distributed in this water body. In addition to these, the organic matter is also an influencing factor for higher diversity. The high diversity of Visakhapatnam Harbour complex appears to reflect optimum conditions of salinity, depth, substrate and increased availability of nutrients (Williamson, 1985). The occurrence of two phytoplankton blooms in the marginal water bodies along this part of the East Coast of India (Ganapathi and Sarma, 1958) are coincident with enrichment of nutrients and sediment organic matter content.

In general, the results of these marginal water bodies reveals that the diversity increases from headward regions to mouth due to the increase of salinity (Boltovskoy, 1976; J. OHO R. Hermalin, 1987) which is a worldwide observation. Similarly, the middle marginal water bodies such as Balacheruvu stream, Visakhapatnam Harbour complex and Gosthani estuary show high diversity values than the other areas.

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